

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	IB Docket No. 11-109
Comment Sought on Ligado's)	
Modification Applications)	SAT-AMD-20180531-00044
)	SAT-AMD-20180531-00045
To: The Commission)	

COMMENTS OF LIGADO NETWORKS LLC

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EXECUTIVE SUMMARY

The occasion for today’s comments by Ligado Networks LLC (“Ligado”) is Ligado’s May 31, 2018 Amendment (“Amendment”) to its license modification applications (“Modification Applications”). As illustrated in these Comments, the Amendment provides important supplemental information the Commission needs to approve the Modification Applications. Since Ligado filed its Modification Applications more than two-and-a-half years ago, the company has worked with federal and industry stakeholders to ensure that its proposed use of this spectrum would not cause harmful interference to GPS receivers. Key points discussed in the Amendment include:

- The Amendment caps Ligado’s power in the 1526-1536 MHz band (“Lower Downlink Band”) at a level of 9.8 dBW (10 Watts). This codifies the determination of both the Federal Aviation Administration and the Department of Transportation that this power limit will protect certified aviation GPS receivers, including helicopters, the most restrictive use case.
- This new power limit — a reduction of more than 99.3% from the nominal 32 dBW EIRP maximum set forth in the Modification Applications and a reduction of more than 99.9% from the level authorized in 2010 — **benefits not only certified aviation devices, but all GPS receivers**. Ligado’s coexistence agreements with major GPS manufacturers and thousands of hours of empirical testing further evidence that other classes of GPS devices will be protected by Ligado’s revised operational parameters.

Ligado is also committed to providing specific mitigation measures to address concerns about potential impact on U.S. government devices. If necessary, these measures include the repair or replacement of such devices, both pre- and post-deployment.

At a time when our country’s leadership in 5G is threatened and spectrum resources are scarce, the Commission has before it the opportunity to make 35 megahertz of mid-band spectrum available to drive forward the transition to 5G and hasten development of the Internet of Things (“IoT”). By approving the Modification Applications first submitted by Ligado in

2015, the Commission would open the door to billions of dollars in consumer benefits and thousands of new American jobs.

The question before the Commission, codified in the FCC's rules, is whether Ligado's proposed operations would cause harmful interference. This familiar standard, also embodied in the NTIA's Spectrum Manual, can be assessed by reference to the substantial analysis and testing in the docket. Ligado urges the Commission to promptly approve the amended Modification Applications. Significant benefits to America's citizens, industries, and spectrum leadership will result from such approval.

TABLE OF CONTENTS

I.	INTRODUCTION AND SUMMARY	2
II.	THE COMMISSION SHOULD ADOPT THE POSITION OF THE FAA AND DOT THAT A POWER LIMIT OF 9.8 dBW (10 W) IN THE LOWER DOWNLINK WILL PROTECT CERTIFIED AVIATION DEVICES.....	4
III.	LIGADO’S AMENDMENT PROVIDES FURTHER PROTECTION FOR GPS DEVICES.....	9
IV.	LIGADO IS COMMITTED TO PROVIDING SPECIFIC MITIGATION MEASURES TO ADDRESS CONCERNS ABOUT POTENTIAL IMPACT ON U.S. GOVERNMENT DEVICES.....	14
V.	CONCLUSION	17

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COMMENTS OF LIGADO NETWORKS LLC

Since Ligado Networks LLC (“Ligado”) filed its license modification applications (“Modification Applications”) more than two-and-a-half years ago, the company has worked with federal and industry stakeholders to ensure that its proposed use of this spectrum would not cause harmful interference to GPS receivers. The occasion for Ligado’s comments today is the May 31, 2018 Amendment (“Amendment”) to the Modification Applications. The further power reductions to which Ligado committed in the Amendment codify the determination of both the Federal Aviation Administration (“FAA”) and the Department of Transportation (“DOT”) that capping Ligado’s power in the 1526-1536 MHz band (“Lower Downlink Band”) at a level of 9.8 dBW (10 Watts) will protect certified aviation GPS receivers. The information already in the docket, including Ligado’s coexistence agreements with major GPS manufacturers and thousands of hours of empirical testing, evidence that Ligado’s operations will protect all other classes of GPS devices. Further, as Ligado has shown over the last several years, it is committed to working cooperatively with government stakeholders and the GPS industry to ensure devices that rely upon GPS signals are adequately protected.

The task before the FCC now is to assess whether, given the evidence before it, Ligado’s proposed operations can co-exist with neighboring incumbent operations. Ligado urges the

Commission to review the substantial docket before it, and promptly approve the amended Modification Applications. Significant benefits to America’s citizens, industries, and spectrum leadership will result from such approval.

I. INTRODUCTION AND SUMMARY

On May 31, 2018, Ligado filed an Amendment to its December 31, 2015 Modification Applications.¹ The Amendment fulfills the commitment Ligado first made in the Modification Applications to protect certified aviation GPS receivers by restricting its operations to power levels below thresholds determined by the FAA. After two years of work and analysis by the FAA and its then-advisory organization, RTCA Inc.², and further review by the DOT, Ligado submitted the Amendment to codify the determination by the DOT that a level of 9.8 dBW (10 W) should be established for Ligado’s power in the Lower Downlink Band.

The new power level detailed in the Amendment reflects the substantial analysis of Ligado’s proposed operations, using a conservative propagation model developed by the FAA to ensure protection of certified aviation GPS receivers, as well as the conclusion of the DOT’s Adjacent Band Compatibility Assessment (the “DOT Report”), which also assessed the needs of certified aviation GPS receivers.³ As amended, the Modification Applications would:

1. Require that Ligado’s ATC base stations operating in the Lower Downlink Band not exceed an EIRP of 9.8 dBW (10 W) with a +/- 45 degree cross-polarized base

¹ Amendment to License Modification Applications, IBFS File Nos. SES-MOD-2015-1231-00981, SAT-MOD-20151231-00090, and SAT-MOD-20151231-00091.

² RTCA is a private, non-profit corporation that previously served as a federal advisory committee to the FAA but the RTCA no longer has that status. *See* RTCA, Mission and History, <https://www.rtca.org/content/mission-history-0> (last visited July 5, 2018).

³ U.S. Department of Transportation, “Global Positioning System (GPS) Adjacent Band Compatibility Assessment,” Final Report, at VI (April 2018), <https://www.transportation.gov/sites/dot.gov/files/docs/subdoc/186/dot-gps-adjacent-band-final-reportapril2018.pdf>.

station antenna (an additional reduction of more than 99.3% from the nominal 32 dBW EIRP maximum set forth in the Modification Applications);

2. Prohibit any Ligado ATC base station in the Lower Downlink Band from operating at a location less than 250 feet laterally or less than 30 feet below an obstacle clearance surface established by the FAA (under 14 C.F.R. Part 77 and its implementing orders and decisions); and
3. Require Ligado to comply with the reporting, notification, and monitoring obligations set forth in Exhibit 1 to the Amendment.

The Amendment thus ensures that Ligado's proposed ATC operations will fully protect certified aviation GPS receivers, including the helicopter use case which the DOT found to be the most restrictive of the certified aviation device applications. As explained in detail below, the Amendment also provides further assurance, above and beyond that demanded by the GPS companies and reflected in the Modification Applications, that Ligado's reduced power levels in the Lower Downlink will not cause harmful interference to other GPS devices.

The Commission has before it all of the information necessary to act on the Modification Applications, with the assurance that Ligado's operational parameters have been established by FAA's and DOT's exacting and challenging model for ensuring the protection of certified aviation GPS receivers. In addition, the agreements with the major GPS device manufacturers, along with the thousands of hours of testing, show that GPS devices will *not* experience harmful interference as a result of Ligado's revised power and out of band emissions levels. Two-and-a-half years after Ligado filed its Modification Applications, no further analysis or testing is necessary to conclude that Ligado's proposal protects certified aviation devices because the model-based EIRP limit proposed in the Amendment already accounts for extreme worst-case interference scenarios that would never conceivably occur simultaneously, and could not even be recreated inside of test chambers—and includes the substantial safety margin embedded in the FAA model.

Moreover, in its cover letter to the Amendment, Ligado stated its commitment to work with federal stakeholders to provide whatever specific mitigation measures may be necessary to address concerns regarding potential impact on certain specific U.S. government devices. The extensive testing by the federal scientists at the National Advanced Spectrum Communications Test Network (“NASCTN”) indicates that the overwhelming number of devices will not experience interference, but Ligado has heard concerns from some government stakeholders that some specialized high-precision devices could potentially be affected, so the company has made this commitment. As explained below, Ligado already has begun discussions with some federal stakeholders, and this approach is consistent with federal procurement laws.

In light of the protection afforded to GPS by the industry-determined parameters set forth in Ligado’s Modification Applications, the substantial record that has been developed since the Modification Applications first were filed in 2015, and the new commitments made in the Amendment, Ligado urges the Commission to approve the amended Modification Applications. At a time when our country’s leadership in 5G is threatened and spectrum resources are scarce, by taking this action the Commission can unlock 35 megahertz of critical mid-band spectrum to serve the industrial Internet of Things (“IoT”) and emerging 5G markets.

II. THE COMMISSION SHOULD ADOPT THE POSITION OF THE FAA AND DOT THAT A POWER LIMIT OF 9.8 dBW (10 W) IN THE LOWER DOWNLINK WILL PROTECT CERTIFIED AVIATION DEVICES.

Ligado arrived at the lower power limits in the Amendment in consultation with the FAA, RTCA, DOT, and numerous stakeholders. The reduced EIRP limits proposed for the Lower Downlink Band were determined through a multi-year process by the FAA in consultation with Ligado, and then further refined by the DOT Report issued in April 2018. This

process was initiated when Ligado filed the Modification Applications on December 31, 2015,⁴ and told the Commission that the company would “limit its power as necessary to achieve compatibility with current and any future [Minimum Operational Performance Standards] insofar as they are incorporated into an active Technical Standard Order by the FAA.”⁵ In addition, Ligado committed to work with the FAA to address any concerns through a process that “would assess aviation-specific use cases and the maximum [Ligado] EIRP that would be consistent with the interference tolerance mask that exists for certified aviation equipment under the RTCA DO-229D and related MOPS, both current and future, that are incorporated into an active Technical Standard Order from the FAA.”⁶

Ligado subsequently spent a year in discussions with the FAA on this issue, and those discussions “yielded a detailed, workable approach to ensuring compliance with all applicable FAA standards and the protection of certified aviation GPS devices,” including with respect to helicopter operations.⁷ This approach — which, like the DOT Report, sets the maximum EIRP for a tower at the level that protects certified aviation GPS receivers operating at any point

⁴ See Modification Applications, Description of Proposed Modification at 6. The level of 32 dBW in the Modification Applications reflects agreements that Ligado reached with various GPS manufacturers, in which the manufacturers requested the company operate at 32 dBW in the Lower Downlink Band. See Letter from Gerard J. Waldron, Counsel to Ligado Networks LLC, to Marlene H. Dortch, FCC Secretary, IB Docket No. 11-109 *et al.*, Attachment at § 6 (Dec. 8, 2015) (Deere & Company settlement agreement); Letter from Gerard J. Waldron, Counsel to Ligado Networks LLC, to Marlene H. Dortch, FCC Secretary, IB Docket No. 11-109 *et al.*, Attachment at § 9(a) (Dec. 17, 2015) (Garmin settlement agreement).

⁵ Modification Applications, Description of Proposed Modification at 7.

⁶ *Id.* at 11.

⁷ Letter from Gerard J. Waldron, Counsel to Ligado Networks LLC, to Marlene H. Dortch, FCC Secretary, IB Docket No. 11-109 *et al.*, Attachment at 10-11 (June 5, 2017) (“Ligado June 2017 White Paper”). See also Letter from Gerard J. Waldron and Michael Beder, Counsel to Ligado Networks LLC, to Marlene H. Dortch, FCC Secretary, IB Docket No. 11-109 *et al.* (Sept. 8, 2016) (describing Ligado’s proposed protocol for protecting certified aviation receivers based on consultations with the FAA).

outside a “standoff cylinder” with a 250-foot radius from the subject tower and extending 30 feet above the antenna⁸ — was submitted to the RTCA in September 2016, and that process was finalized in December 2016.⁹

The DOT Report took a similar approach to what the FAA submitted to RTCA, though it used slightly different assumptions, and concluded that a single power level applicable nationwide was preferable to a site-by-site power determination that the FAA analysis supported. This led the DOT Report to state that an EIRP limit of 9.8 dBW (10 W) (cross-polarized) at 1531 MHz will protect certified aviation receivers operating in accordance with applicable MOPS even under “*the most restrictive of the certified aviation scenarios examined.*”¹⁰

The Amendment thus embodies the DOT Report’s more conservative conclusion with respect to the needs of certified aviation receivers. We urge the Commission to adopt the judgment of the expert agencies that 9.8 dBW (10 W) will protect certified aviation devices. This reduced power level represents a profound reduction compared to the operating parameters previously proposed for this band. Approval of the Modification Applications, as amended, would reduce the EIRP limit for ATC base stations in the Lower Downlink Band from 42 dBW (the currently licensed level) to 9.8 dBW (10 W) — representing a power reduction of more than 99.9% (from 15,850 W to 10 W) from the level authorized in 2010,¹¹ and a reduction of more

⁸ Compare Ligado June 2017 White Paper at 25-26 with DOT Report at VI-VII.

⁹ Ligado June 2017 White Paper at 11.

¹⁰ DOT Report at VI, 118-19, 149, 152-53 (emphasis added). Consistent with FAA practice in performing radiofrequency assessments for safety-of-life functions, the DOT analysis applies a safety margin of 6 dB to its analysis. This safety margin is in addition to all of the other highly conservative assumptions and layered worst-case scenarios that are the basis for the certified aviation analysis.

¹¹ *Skyterra Subsidiary LLC*, Order and Authorization, 25 FCC Rcd 3043, 3058 (IB 2010).

than 99.3% (from 1,585 W to 10 W) from the 32 dBW EIRP maximum proposed in the Modification Applications. To be clear, this codified 9.8 dBW (10 W) EIRP limit would apply to all Lower Downlink Band ATC base stations nationwide and thereby would benefit all GPS receivers.

As noted above, the DOT recommends an EIRP of 9.8 dBW as appropriate for meeting “the most restrictive of the certified aviation scenarios examined.”¹² Consultant James H. Williams, a former FAA director with deep experience with the FAA’s process for assessing an applicant’s compliance with aviation regulations, has reviewed all the available information from the FAA and DOT, and states in his attached declaration that “the model-based analysis conducted by Ligado, the FAA, the Department of Transportation, and other various experts demonstrates that Ligado’s proposed operations will not create a safety risk to aircraft using certified GPS devices manufactured in compliance with an applicable FAA Technical Standard Order.”¹³

Certain aviation parties recently called for testing.¹⁴ Mr. Williams makes clear that further testing — particularly “operational” testing, as referenced in the parties’ letter, which we refer to herein as “real-world” testing, encompassing both lab testing and field testing — would provide no additional helpful information to assess Ligado’s proposal. While the FAA regularly uses real-world testing to evaluate various situations, it also uses highly specific models in situations like this one where real-world testing of all possible scenarios is impossible.¹⁵ To

¹² DOT Report at VI, 118-19, 149, 152-53 (emphasis added).

¹³ Declaration of James H. Williams, Exhibit A at ¶ 5.

¹⁴ Letter from Airline Pilots Association, International et al. to Daniel K. Elwell, Acting Administrator, FCC (June 15, 2018), IB Docket No. 11-109 (filed June 18, 2018).

¹⁵ Declaration of James H. Williams, Exhibit A at ¶ 6.

properly determine how Ligado could safely operate without harmful interference to certified aviation receivers, the FAA needed to evaluate a “nearly infinite number” of possible situations.¹⁶ RF propagation is affected by many factors: antenna and receiver locations; aircraft speed, direction, and bank angles; weather and vegetation; landscape, structure, and topography; and ground reflectivity. By using a model, the FAA could evaluate these myriad situations and ensure that even where the rarest, worst-case scenarios were stacked on top of each other, Ligado’s operations posed no threat to certified aviation devices.

These rare and worst-case conditions that form the basis of the DOT conclusion would be impossible to create simultaneously in the field or in a lab. For example, the FAA addressed the vagaries of RF interference under the worst possible circumstances, such as assuming the ground around a transmitter is perfectly reflective.¹⁷ Real-world testing would be “dramatically less conservative” because of the inability to simulate these rare, worst-case scenarios that are necessary to address aviation safety.¹⁸ As a result, “real-world testing of Ligado’s operations would . . . result in a *higher* permissible power level for Ligado’s operations than is indicated by the models developed by the FAA.”¹⁹

The aviation community knows well that the FAA’s models are more restrictive than any real-world scenario. For example, in the proceedings before the RTCA, the aviation interests repeatedly stressed the need to account for all possible “worst case” scenarios, which Ligado readily accepted consistent with its commitment in the Modification Applications. Indeed, when Ligado’s predecessor suggested a less restrictive interference assessment scenario for this

¹⁶ *Id.* at ¶ 7.

¹⁷ *Id.* at ¶ 8.

¹⁸ *Id.* at ¶ 6.

¹⁹ *Id.*

spectrum, the aviation and GPS communities objected and advocated for the use of the stricter RTCA models, rather than real-world performance testing, as the appropriate assessment tool. For example, Garmin argued that the spectrum “must be tested using propagation models” to “accurately reflect aviation in-flight conditions.”²⁰ The General Aviation Manufacturer’s Association criticized Ligado predecessor LightSquared’s estimates, instead advocating for “the model actually employed in the RTCA, Inc. analysis, which is based on published performance standards for GPS receive antennas.”²¹

The aviation and GPS communities previously advocated for assessing this spectrum with the FAA and RTCA models. Ligado agreed to do so in the Modification Applications, and has now delivered on that commitment. To conform its operations to these models, in the Amendment, Ligado proposed a cumulative power reduction in the Lower Downlink Band of more than 99.9% from the level authorized in 2010 (a reduction of more than 99.3% from the maximum reflected in the Modification Applications). Now that Ligado has met the call of these stakeholders to comply with the FAA and RTCA models, the recent shift in position by some in the aviation community for real-world testing rings hollow. And since it would not yield any additional relevant information, testing is not necessary.

III. LIGADO’S AMENDMENT PROVIDES FURTHER PROTECTION FOR GPS DEVICES.

Another benefit of the Amendment is to provide further protection to non-certified GPS devices. As explained previously, the co-existence agreements Ligado reached with major GPS

²⁰ Letter from Russell H. Fox, counsel to Trimble Navigation, Ltd. and M. Anne Swanson, counsel to Garmin International, Inc. to Marlene H. Dortch, Secretary, FCC, IB Docket No. 11-109 at 46 (Sept. 15, 2011) (discussing non-certified devices).

²¹ Comments of the General Aviation Manufacturer’s Association, IB Docket No. 12-340 et al., at 5, (Sept. 6, 2013).

manufacturers indicate that the reduced operational power and out of band emissions levels proposed by Ligado and *specifically requested by the GPS companies to be submitted as license modifications*, meet the needs of GPS devices.²² This conclusion has been confirmed by the thousands of hours of empirical testing to assure Ligado’s operations at the agreed-upon levels will not affect the operations of all other classes of GPS devices.²³ These devices will receive even greater protection than required by the GPS industry from the lower power level reflected in the Amendment, which, as stated above, represents a 99.3% reduction from the EIRP maximum reflected in the Modification Applications.

The DOT Report creates unnecessary confusion on this point. In a section that speaks to the matter before the Commission, the DOT Report concludes that an EIRP limit of 9.8 dBW (10 W) (cross-polarized) at 1531 MHz will protect certified aviation receivers operating in accordance with applicable MOPS even under “*the most restrictive of the certified aviation scenarios examined.*”²⁴ However, the DOT Report also includes sections that report on testing of whether GPS devices experience a change in an “interference protection criterion” and based on this criterion observes that certain non-certified GPS devices may not be protected against that particular kind of impact at 9.8 dBW (10W). How can one part of the DOT Report be applicable to the case at hand and the other be inapplicable? Because of the critical difference in

²² See Ligado June 2017 White Paper at 7-8.

²³ See generally Roberson and Associates, LLC, “Results of GPS and Adjacent Band Co-Existence Study,” IB Docket No. 11-109 (May 11, 2016) (“RAA Report”); Dr. William Young et al., NASCTN, LTE Impacts on GPS: Test and Metrology Plan (July 22, 2016), available at <https://www.nist.gov/sites/default/files/revise-test-plan-impact-of-lte-on-gps-22-july-2016.pdf> (“NASCTN Report”); see also Ligado June 2017 White Paper at App’x A, pp. 17-21 (analyzing results of RAA Report, NASCTN Report).

²⁴ DOT Report at VI, 118-19, 149, 152-53 (emphasis added).

the approach the DOT Report took in evaluating certified aviation receivers and evaluating all other GPS receivers.

The DOT Report's assessment of certified GPS avionics was led by the FAA, which appropriately based its analysis on the principle that such devices "meet their performance requirements when operating within the RF interference (RFI) environment defined in appropriate FAA Technical Standard Orders (TSOs)."²⁵ The DOT Report's analysis of other GPS devices, on the other hand, did not examine whether they meet their performance requirements or even whether they experience harmful interference; instead, it examined whether a GPS device experienced a 1 dB increase in a GPS device's idiosyncratic and self-reported carrier-to-noise-density ratio ("C/N₀"). The DOT refers to this metric of *impact* as an "interference protection criterion" ("IPC").²⁶ As Ligado has explained elsewhere, a 1 dB change in a device's C/N₀ has no reliable relationship to the actual performance of GPS devices.²⁷ More fundamentally, the DOT Report did not provide information that speaks directly to the issues before the Commission because the DOT did not study harmful interference.

²⁵ *Id.* at II. Importantly, this distinction was driven by the underlying regulatory requirements, which permit *only* certified GPS receivers to be used for primary navigation, instrument procedures, and other regulated operations. Accordingly, certified aviation receivers present critical safety of life issues. In comparison, under FAA regulations, noncertified aviation receivers are treated as any other consumer grade GPS devices. For this reason, for example, the manuals accompanying Garmin's noncertified GPS receivers contain a warning: "Do not use . . . for primary navigation." Instead, the manuals state that these devices are to be used only "to enhance situational awareness." Garmin, Pilot's Guide Aera Models 795 and 796.

²⁶ DOT Report at 44-45.

²⁷ See Letter from Gerard J. Waldron, Counsel to Ligado Networks LLC, to Marlene H. Dortch, FCC Secretary, IB Docket No. 11-109, at 2-3 (April 12, 2018); Ligado June 2017 White Paper at 21-24.

It is critical to note that the DOT Report *did not assess and never discusses harmful interference*, which is the relevant question for both the NTIA²⁸ and the FCC,²⁹ because unlike the tests performed by NASCTN, DOT made a deliberate decision not to test for how Ligado’s operations would actually affect the performance of GPS devices. Ligado repeatedly urged the DOT to include testing for harmful interference while the test plan was being developed, but DOT opted not to use that metric.³⁰ Instead, the Department chose to assess its IPC, which imposes far more restrictive and unprecedented limitations on spectrum usage than the harmful interference standard. Use of the IPC would be inconsistent with spectrum regulations, and it would not only preclude Ligado’s use of this spectrum in a manner consistent with its existing ATC authorization,³¹ but it also would block use of spectrum adjacent to GNSS on either side of the allocation for more than 60 megahertz for any commercial purpose, and imperil spectrum identified in the Spectrum Pipeline Act of 2015.³²

²⁸ See NTIA Spectrum Manual at § 2.3.6 (*see* text and note accompanying note 38, *infra*).

²⁹ 47 C.F.R. § 2.1 (“Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Radio Regulations.”).

³⁰ *See e.g.*, Letter from Gerard J. Waldron, Counsel to Ligado Networks Inc., to Karen Van Dyke, Director, Office of Positioning, Navigation and Timing and Spectrum Management, Department of Transportation (Apr. 29, 2016) (recommending changes to the test plan).

³¹ Use of the IPC would destroy any commercial utility of the Lower Downlink Band, constructively nullifying Ligado’s authorization to use of the spectrum without affording Ligado the required administrative procedures or compensation.

³² Pursuant to the Spectrum Pipeline Act of 2015, Title X of the Bipartisan Budget Act of 2015, Public Law 114-74, 129 Stat. 621 (Nov. 5, 2015), the 1300-1370 MHz band is under study for terrestrial wireless service. This “Pipeline Spectrum” could enable the commercial wireless sector to expand into additional spectrum and provide additional service. At the same time, the Commission is considering authorizing use of the Galileo GNSS system in the U.S., including one signal at 1260-1300 MHz, directly adjacent to the Pipeline Spectrum. Transposing DOT’s application of the 1 dB standard to the L-band to Galileo, if spectrum regulators use the 1 dB metric to protect Galileo, it will render substantial portions of the Pipeline Spectrum essentially unusable.

The profound difference between an IPC and harmful interference was acknowledged by the DOT Volpe staff that conducted the ABC Report testing. During DOT's final workshop on the ABC Report in March 2017, one of the authors of the ABC Report clarified: "Again, we mentioned multiple times that we were looking at 1 dB as a protection criteria, *not necessarily as the harm criteria . . .*"³³ The inaptness of the DOT Report is countered by the evidence in the record from the government's scientists at NASCTN³⁴ and from Roberson and Associates,³⁵ both of which tested whether Ligado's operations will interfere with the functioning of GPS devices. There is no need to repeat that analysis here except to summarize it by stating that, consistent with the evident conclusions of the GPS device manufacturers, Ligado's operations and GPS devices can co-exist as spectrum neighbors.³⁶

The question before the Commission is whether the proposed spectrum operations can co-exist with adjacent spectrum operations.³⁷ This Commission analyzes this question by assessing whether devices experience harmful interference, and this is the same policy metric embodied in NTIA's Spectrum Manual:

The Federal Government considers that the basic guide to follow in the normal assignment of radio frequencies for transmission

³³ Statement of Hadi Wassaf at the March 30, 2017 Workshop (the sixth workshop on the Compatibility Assessment) (emphasis added).

³⁴ See NASCTN Report.

³⁵ See RAA Report.

³⁶ See, e.g., Ligado June 2017 White Paper at App'x A, pp. 17-21.

³⁷ The Department of Transportation is not a spectrum regulator and has no authority to make spectrum decisions, and consequently the Commission need not show any deference to DOT's recommendation on appropriate spectrum standards. *Head v. New Mexico Bd. of Examiners in Optometry*, 374 U.S. 424, 430 n.6 (1963). See also *New York SMSA Ltd. P'ship v. Town of Clarkstown*, 612 F.3d 97, 100 (2d Cir. 2010) (Congress "intended the FCC to possess exclusive authority over technical matters related to radio broadcasting"); *Broyde v. Gotham Tower, Inc.*, 13 F.3d 994, 997 (6th Cir. 1994) (discussing "the FCC's exercise of exclusive jurisdiction over the regulation of radio frequency interference").

purposes is *the avoidance of harmful interference* and the use of frequencies in a manner which permits and encourages the most beneficial use of the radio frequency spectrum in the national interest.³⁸

The Commission must keep this question front of mind as it assesses Ligado's amended Modification Applications.³⁹

IV. LIGADO IS COMMITTED TO PROVIDING SPECIFIC MITIGATION MEASURES TO ADDRESS CONCERNS ABOUT POTENTIAL IMPACT ON U.S. GOVERNMENT DEVICES.

As the FAA and DOT determined, with the operational parameters set forth in the Amendment, certified aviation devices will be protected. The above discussion shows that other GPS devices also will not experience harmful interference. Nonetheless, despite this evidence showing that the overwhelming number of devices will not be affected, Ligado is aware that some federal stakeholders have concerns that some specialized devices, particularly high precision devices, may need to be repaired or replaced. Ligado does not expect any devices to experience harmful interference, and this conclusion is buttressed by the co-existence agreements with the major GPS manufacturers, including the leading high precision device makers. However, out of an abundance of caution Ligado has made a commitment to provide specific mitigation measures to address concerns about potential impact on U.S. Government devices, including the repair or replacement of such devices as necessary, both pre- and post-deployment

³⁸ NTIA Spectrum Manual at § 2.3.6 (emphasis added). The Federal Radionavigation Plan further charges NTIA's parent agency with "protecting space-based PNT spectrum through appropriate spectrum management that preserves existing and evolving uses of GPS *while allowing development of other radio frequency technologies and services*". See Federal Radionavigation Plan at 2-16.

³⁹One prominent GPS company already has commented that the Commission can determine whether or not Ligado's proposed operations would cause harmful interference without deciding whether the 1 dB standard is an appropriate method for determining harmful interference in all cases involving GPS. See Comments of Trimble Navigation Limited, IB Docket No. 11-109 et al. at 4 (May 23, 2016).

of Ligado’s proposed terrestrial network. Ligado can undertake this effort to repair and replace GPS devices consistent with the views of the Government Accountability Office (“GAO”) and under federal appropriations law and general agency contracting authorities.

It is true that agencies are generally limited in their ability to accept equipment from third parties, but GAO, which has authority to issue decisions to agencies regarding the use of public funds, has recognized at least two applicable exceptions to these limitations. The first exception permits agencies to accept repair or “in-kind” replacement of Government property that has been adversely impacted by a third party. The second exception permits agencies to enter into “no-cost” contracts to accept the provision of goods or services where adequate non-monetary consideration exists (*i.e.*, where both parties to the contract benefit from the relationship). Either of these exceptions provides the authority necessary to support a program funded by Ligado to repair or replace federal agency devices that may be impacted as a result of its operations.

Federal agencies are generally subject to certain limitations on the use and retention of funds received from third parties absent explicit authority to do so.⁴⁰ The limitations on agencies include (i) the “miscellaneous receipts” statute, which requires agencies to deposit any funds they receive into the U.S. Treasury “as soon as practicable,” (ii) a requirement that authority to make payments in excess of an appropriation must be explicit in the relevant statute, and (iii) a general prohibition on the acceptance of voluntary services.⁴¹

Notwithstanding these considerations, there are exceptions that permit Ligado to fund the repair and/or replacement of affected federal devices. The first exception permits the repair or

⁴⁰ See *e.g.*, Letter to Robert Benson, *Gifts of Goods and Services to the Government*, B-289903 (Mar. 4, 2002); *National Bureau Of Standards - Contributions from Private Sources*, B-128527, 36 Comp. Gen. 268 (Oct. 2, 1956).

⁴¹ 31 U.S.C. § 3302; 31 U.S.C. § 1301; and 31 U.S.C. § 1342.

in-kind replacement of Government property that has been damaged by a third party.⁴² The basic rationale for this exception is that “there are no funds received” by the federal agency.⁴³ The exception would apply even if the money must have been deposited to the Treasury as a miscellaneous receipt if the responsible party paid it directly to the Government rather than provide replacement property.⁴⁴

The second exception allows agencies to enter into agreements for “no-cost” conveyances if adequate non-monetary consideration exists.⁴⁵ This exception applies even if an agency has no specific statutory authority to accept gifts.⁴⁶

Regarding this second scenario, an example of a situation that is closely analogous to the program that Ligado seeks to establish is described in a 2001 GAO decision where GAO permitted the District of Columbia Courts to accept and use a contribution of

⁴² See *Maritime Administration - Disposition of Funds Recovered from Private Party for Damage to Govern Building*, B-287738, 2002 WL 1554364 (May 16, 2002) at *3.

⁴³ See *id.*, citing *Bureau of Alcohol, Tobacco, & Firearms-Augmentation of Appropriations- Replacement of Autos by Negligent Third Parties*, B- 226004, 67 Comp. Gen. 510, 511 (July 12, 1988) (“[T]he miscellaneous receipts statute is applicable only when money, as opposed to goods or services, has been provided to the agency.”); see also *Letter to the Secretary of Commerce*, B-87636 (Aug. 4, 1949) (finding that replacement of a damaged truck did not require a credit to the Treasury under the same rationale).

⁴⁴ See *Bureau of Alcohol, Tobacco, & Firearms*, 67 Comp. Gen. at 511.

⁴⁵ See e.g., *LCPtracker, Inc.; eMars, Inc.*, B-410752.3 et al., 2015 CPD ¶ 279 at *1 (Sep. 3, 2015) (permitting an offeror to submit a zero-dollar bid in exchange for increased marketplace exposure associated with performance of a government contract); *Gen. Servs. Administration: Real Estate Brokers' Commissions*, B-291947, 2003 WL 21947188 (Aug. 15, 2003) (permitting GSA to enter into agreements with real estate brokers to accept “free” services associated with lease acquisition services because realtors were compensated by the property owners, rather than by GSA).

⁴⁶ See *Fed. Comm'n's Comm'n-Acceptance of Rent-Free Space & Servs. at Expositions & Trade Shows*, B-210620, 63 Comp. Gen. 459 (June 28, 1984) (finding free exhibit space permissible where event promoters benefitted from the Commission’s presence at trade show and noting that the “mutually beneficial arrangement is neither an augmentation of appropriations nor an illegal retention of a gift.”).

telecommunications services and equipment from Verizon as part of a settlement agreement from a rate case.⁴⁷ As part of the settlement agreement, Verizon established an “infrastructure fund” which, among its purposes, included plans to finance advanced telecommunications projects for the District of Columbia Court of Appeals and Superior Court.⁴⁸ After concluding that the District of Columbia Courts had authority to accept gifts, GAO opined that the transaction between Verizon and the District of Columbia arguably may not be a gift, in part, because “Verizon . . . received consideration from the District of Columbia through the approval of its rate plan and a release from further concessions or requirements; in return, the District of Columbia will receive valuable goods and services.”⁴⁹ GAO’s rationale as to why the arrangement was permissible if treated as a non-gratuitous conveyance for mutual consideration would likely support a similar repair or replacement program for any Ligado-affected devices.

Both of these exceptions provide authority for federal agencies to accept repaired or replaced agency devices that may be impacted by Ligado’s operations. Ultimately however, the success of any approach depends on close collaboration between Ligado and the Government to establish a program that is beneficial to both parties. As such, Ligado looks forward to continued discussions with the Government to define the parameters of such a program.

V. CONCLUSION

The Commission has before it all of the information necessary to consider Ligado’s Modification Applications. The Amendment assures protection for certified aviation GPS receivers as well as all other GPS receivers. This conclusion is supported by the certified

⁴⁷ See *Contribution of Telecommunications Servs. to the D.C. Courts*, B-286182, 2001 WL 50524 (Jan. 11, 2001).

⁴⁸ *Id.* at *2.

⁴⁹ *Id.* at *4.

aviation recommendations of the DOT Report, Ligado's coexistence agreements with major GPS manufacturers and thousands of hours of empirical testing, all of which evidence that all other classes of GPS devices will not be adversely affected by Ligado's revised operational parameters. More than two-and-a-half years after filing its initial Modification Applications, Ligado urges the Commission to consider the record and approve the amended Modification Applications without delay. Doing so will unlock billions of dollars in consumer benefits, generate thousands of American jobs, and advance U.S. leadership in spectrum technology.

Respectfully submitted,

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EXHIBIT A
DECLARATION OF JAMES H. WILLIAMS

1. My name is James H. Williams. I am the Founder and President of JHW Unmanned Solutions LLC. I have more than 35 years of experience in the aerospace sector. Over the course of my career, serving in both the government and in the private sector, I have developed substantial expertise in the process of testing and coordination necessary to integrate new devices and technologies into the National Airspace System (“NAS”).

2. Prior to founding JHW Unmanned Solutions, I spent 28 years at the Federal Aviation Administration (“FAA”). I held many roles in my career at the FAA. Most recently, I led the newly formed Unmanned Aircraft Systems (“UAS”) Integration Office. In this role, I was responsible for coordinating all the FAA’s efforts to integrate UAS into the NAS. Before taking that position in 2012, I was the Director of Systems Engineering and Safety for the FAA’s Next Generation Air Transportation System (“NextGen”), the agency-led modernization of the air transportation system to make flying safer, more efficient, and more predictable. In this role, I led the coordination and integration of all systems engineering work needed to move the NAS toward NextGen. I also held several FAA positions related to the regulation and certification of avionics systems.

3. In the private sector, I have served as a Principal at Dentons, advising aviation clients on all aspects of manned and unmanned aircraft regulatory issues, and as a flight test engineer and production liaison engineer for Lockheed Georgia Company, a subsidiary of Lockheed Martin. Since 2016, I have served as a consultant to Ligado Networks LLC (“Ligado”).

4. I earned a BS in Aerospace Engineering with honors from the Georgia Institute of Technology.

5. Based on my deep familiarity with the FAA's process for assessing a new applicant's compliance with aviation regulations, it is my opinion that the model-based analysis conducted by Ligado, the FAA, the Department of Transportation, and other various experts demonstrates that Ligado's proposed operations will not create a safety risk to aircraft using certified GPS devices manufactured in compliance with an applicable FAA Technical Standard Order. A principal reason for this conclusion is that Ligado's proposed transmissions would operate pursuant to propagation and interference models developed by the FAA to assess GPS interference across a wide range of situations and circumstances that are not possible to test in real-world circumstances.

6. Although the FAA regularly uses real-world testing, such as field or lab testing, to evaluate various situations (including flight test data, avionics standards compliance testing, aircraft structural strength and fatigue testing, etc.), it also regularly uses highly specific models for simulating situations where real-world testing of all possible scenarios is impossible. An example of this approach would be the extensive simulations conducted to develop and validate the computer software that is incorporated in avionics that prevent midair collisions (Traffic and Collision Avoidance Systems a.k.a. TCAS). The assessment of potential interference between Ligado's proposed network and certified GPS receivers is a situation where modeling is the most appropriate and safety enhancing approach to assessing interference. Indeed, real-world testing in this situation would be dramatically less conservative because of the inability to create the great variety of rare and worst case scenarios that are necessary to address aviation safety. As a result, real-world testing of Ligado's operations would, in my opinion, result in a *higher* permissible power level for Ligado's operations than is indicated by the models developed by the FAA.

7. To conduct a comprehensive assessment of Ligado's proposed operation, the FAA would have to conduct a nearly infinite number of tests or evaluations to address all possible situations. RF propagation is a complex engineering problem that is difficult to test because there are so many variables that cannot be captured in even the most complex real-world tests. RF propagation is affected by many factors including: antenna and receiver locations; aircraft speed, direction, and bank angles; weather and vegetation; landscape, structure, and topography; and ground reflectivity. Even the presence or absence of leaves on trees can influence the received signal strength at a specific location.

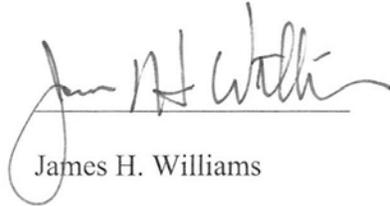
8. The FAA developed a propagation model that considers all possible aspects of RF signal propagation, including probability of occurrence of the worst-case interfering signals in extreme environments. In many situations, the FAA addressed the vagaries of RF interference by assuming the worst possible situation, such as assuming the ground around a transmitter is perfectly reflective. The model stacks each of these improbable events on top of one another to assess the theoretical worst case impact of Ligado's transmissions in these rare situations that would be impossible to create in the real world. In the interest of aviation safety, the model is "conservative," because it assumes that all possible RF propagation conditions that could cause interference — even those with a one in a million chance of occurring — will occur simultaneously at the precise location of the theoretical minimum performance GPS receiver. Ligado's proposed network of transmitters will be built to this exacting and challenging standard.

9. The license modification applications now before the FCC are based on this model. The model itself was developed by the FAA's subject matter experts. The FAA also tasked their Federal Advisory Committee, RTCA Inc., to bring together a group of subject matter

experts from the aviation industry to evaluate the model and Ligado's proposed approach to establishing and operating its network.

10. Any number of real-world tests would result in much less stringent requirements upon Ligado than they have agreed to meet using the propagation models developed by the FAA. It would be impossible to create the array of situations in the real world that has already been assessed using the model. Moreover, because the model assumes multiple worst case situations exist simultaneously, any real-world testing will lead inarguably to a *higher* likelihood of conditions occurring that would cause interference to GPS receivers. The FCC can therefore act confidently, based on the data it has now, and grant Ligado's license modification applications, because it is extremely improbable that Ligado's proposed network will cause harmful interference to FAA-certified GPS devices.

Signed:



James H. Williams

Date:

July 9, 2018